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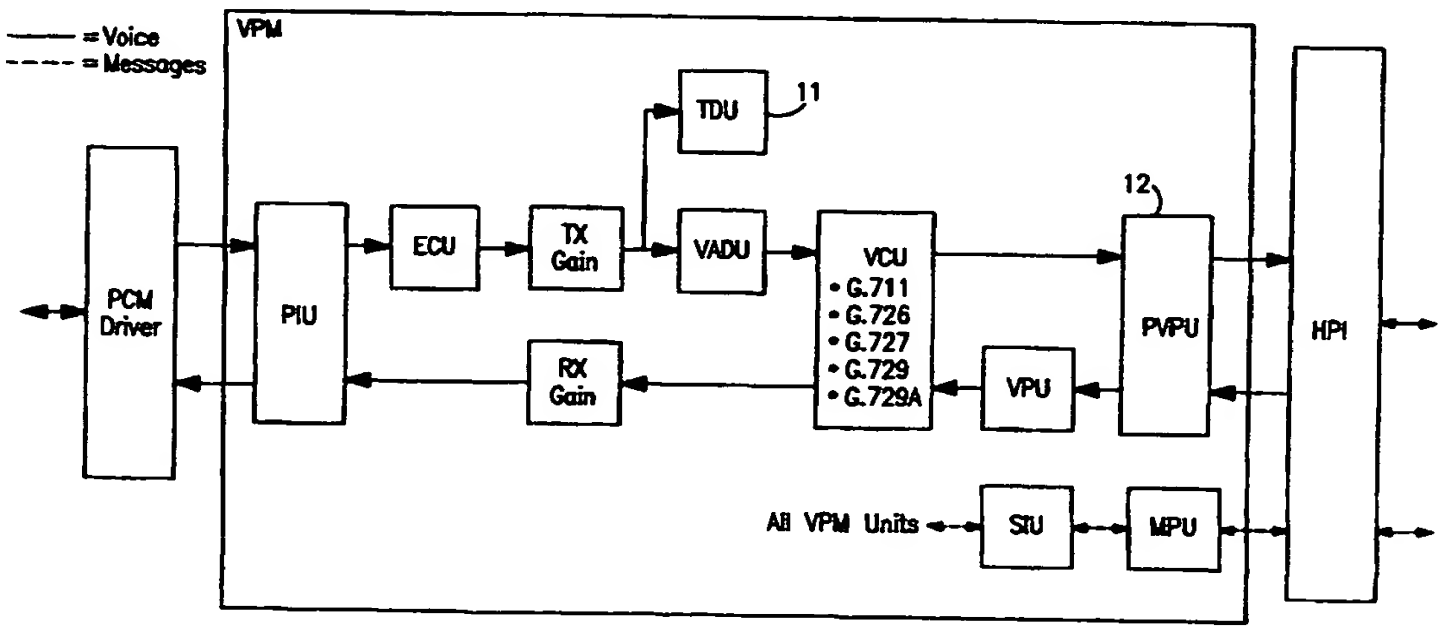
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: FAST DTMF IDENTIFICATION



(57) Abstract: A method of detecting control tones in a digital signal by using a tone detection unit (11) (TDU) and a packet voice protocol unit (12) (PVPU) in a network over which the signal is transmitted. The TDU (11) detects the presence of a control tone in the signal within the first 5 ms of transmission and generates an alert signal (23) to the PVPU (12) to cease further transmission of the signal. Upon confirmation, the PVPU (12) may halt the transmission and buffer or delete the voice signal packets. Alternatively, if the control tones are not present in the signal, the PVPU (12) may continue transmission of any buffered packets. The method further incorporates the sending of the control tone signal to the receiving end of the transmission of the voice packets following transmission of the control tone to the receiving end.

WO 01/13586 A1

FAST DTMF IDENTIFICATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to methods for signal processing based on detection of tones in a digital or analog signal. More specifically, the present invention relates to signal processing between detection and confirmation of specified signals within a digitized signal stream which includes a mixture of signals.

2. Discussion of Related Art

Analog signals, such as voice are often compressed through application of codecs during conversion to digital data or form for transmission. The use of codecs to compress the information into digital form allows for enhanced transfer through reducing the size of the data. Because of the qualities of spoken conversation, voice can be compressed and restored through application of a codec with minimal degradation in the integrity of the comprehension of the sound, even with the use of low byte rate codecs. Accordingly, low byte rate codecs are often used to compress voice, especially in voice over packet network applications.

However, low byte rate codecs can have a significant drawback in the distortion of non-voice signals such as Dial Tone Multi-Frequency (DTMF) or other control tones. Distorted DTMF tones or other control tones or signals can be misidentified or missed altogether by the receiving equipment and subsequently improperly processed or ignored. In order to avoid reception of distorted signals, tones are passed out of band according to ITU Recommendation H.323. (ITU Recommendation H. 323 is a standard approved by the International Telecommunication Union (ITU) that defines how audiovisual conferencing data is transmitted. In theory H. 323 should enable users

to participate in the same conference even though they are using different video conferencing applications.) Tones are detected and identified initially at the transmission side, before encoding, and the identity of the tone is sent out of band as a control message between two ends of a connection using reliable transport (TCP) mechanisms. The DTMF tone is regenerated at the receiving end without distortion. Before the tone can be passed, identification and recognition of the tone must be established for a set period of time to avoid false generation of tones. The regenerated tones are out of synchronization with the voice path because of differential delay through the transmission medium because each travels overa different data path. Therefore, the out of band control signal or tone is not in synchronization with the voice packets.

During the tone detection process, a DTMF detector typically takes about 30-40 milliseconds (ms) to fully qualify DTMF tones. ITU Q.24 requires that a DTMF signal be present for 30ms before being declared a digit. The voice channel is squelched upon detection of a DTMF tone and the DTMF tone is passed through the out of band channel. Accordingly, a remote detector is triggered by this out of band DTMF and recognizes it as a digit entry.

If any portion of the DTMF tone is leaked through the voice path, the remote detector might be triggered by this leaked DTMF. Since the leaked tone would present first to the remote detector, the later received out of band tone may cause a second detection for a single digit entry. A potential double detection problem exists when the detector detects the same digit entry a second time. Therefore, it is important that the DTMF tone be squelched before any portion of the tone leaks through the voice signal path.

Because the detector at the sending end of the DTMF will take a set period of time to fully qualify the DTMF tone, the tone may be present in the voice path and leak

through for the period of the qualification time, typically 30-40ms. Since the decision to squelch the voice path is made based upon the qualification of the DTMF signal, the DTMF tone will exist on the voice signal for the qualification time, typically 30-40ms, which is sufficient time for the DTMF detector at the receiving end to detect a tone if the tone transmits undistorted in the voice path. The tone will then be sent out of band after qualification. Since a tone duration of 10-30ms is sufficient for detection, the DTMF tone may be detected first on the voice path and then a second time on the out of band path, resulting in double detection.

One method for reducing double detection is the introduction of a 30-40ms delay in the voice path. A sufficient delay in the voice path will allow the voice path to be squelched upon detection, before the tone has passed over the voice path packets. However, any delay introduced into the voice path is highly undesirable since this will increase the end to end delay in the system. Accordingly, it is desirable to develop a method for detecting tones in a voice signal prior to transmitting the voice signal through the network and without introducing undue delay in the transmission.

SUMMARY OF THE INVENTION

It is an object of the present invention to reduce double detection of tones in a voice over packet transmission, without introduction of delay into the transmission system.

It is an object of the present invention to achieve early detection of control tones such as DTMF digits.

It is a further object of the present invention to utilize early detection to buffer voice packets until confirmation and qualification is established.

It is another object of the present invention to use early detection of control tones to reduce the transmission of tones over voice channels without delay

of voice packets.

The present invention further allows for reliable transport of tones through a control channel, without causing false detections on the remote end, or unnecessarily increasing the end to end delay.

In accordance with the invention, these and other objects are achieved by incorporating a tone detection unit into the network for providing early detection of control tones. The method incorporates the use of the tone detection unit in combination with a packet voice protocol unit. Upon transmission of the voice signal, the tone detection unit generates an alert signal to the packet voice protocol unit after an initial detection of a control tone for a 5 ms duration. Based upon the alert signal, the Packet Voice Protocol Unit (PVPU) ceases sending any additional voice packets until confirmation of the control tone is received. The voice packets may either be buffered for later transmission if it is determined that the alert signal was premature, or dropped in the event confirmation of the control tone is received. Accordingly, the Tone Detection Unit (TDU) in combination with the PVPU function to provide an early alert process for detection of control tones in a signal transmission without causing undue delay in the event transmission of the alert signal was improper.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the nature of the present invention, reference is had to the following figures and detailed description, wherein like elements are accorded like reference numerals, and wherein:

Figure 1 is a block diagram illustrating the components of a typical voice over packet transmission circuit.

Figure 2 is an exemplary logic flow diagram illustrating the signal timing of an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS AND BEST MODE OF THE INVENTION

In a preferred embodiment of the present invention, a signal representing a human voice is transmitted through a network. Upon transmission of the signal, a TDU and a PVPU are utilized to determine the presence of any control tones in the transmission, and to prevent transmission of the control tones in the voice packet as early detection of control tones in the transmission signal is desirable to avoid delay in the transmission.

The present invention takes advantage of the early initial detection by the TDU and generates an Alert signal to the Packet Voice Protocol Unit(PVPU) shortly after detection of any tones, but prior to confirmation of the tone. Upon receiving any alert signal, the PVPU stops sending voice packets instead of waiting for confirmation. The PVPU may simply drop the packets after the Alert signal or may buffer the packets for later transmission if the tone is not qualified or confirmed.

If the tone is qualified, any buffered packets are dropped, and the voice channel remains off through the end of the tone transmission. The TDU also sends the out of band tone detect message and the tone for transmission via Transmission Control Protocol (TCP) to the receiving side. When the tone is no longer detected by the TDU, transmission of voice through the packet network is resumed.

If the tone is not qualified or confirmed within a certain timeout period after the Alert message, voice transmission is resumed, and all of the buffered packets are then transmitted. As failure to receive confirmation indicates that the DTMF detector was falsely triggered resulting in a false early initial detection, the resumption of voice packet transmission is desirable to avoid delay in the transmission.

Implementation of the present invention may add delay or jitter to voice transmission in limited

instances when false early detection occurs. The present invention may also result in interruption and loss of voice if a buffer is not utilized when a tone is falsely detected. However, false tone detection is uncommon and the loss or delay of 5-30ms of voice will not cause significant distortion in voice over packet transmission to negate the desirable effect of early detection of control tones.

DTMF detectors are typically aware of the presence of DTMF digits for the entire duration of qualification. The qualification duration period is established to reduce the false detection of DTMF digits. The present invention makes use of the early detection of DTMF digits prior to qualification to act proactivly and stop sending voice to the network as soon as the DTMF detector believes that there is the possibility of a DTMF digit.

As illustrated in Figure 2, the DTMF detector (not shown) in the TDU 11 waits for a tone 21 upon transmission of a signal. Upon an initial DTMF digit detection 22 of approximately 5ms, the DTMF detector in the TDU 11 sends an Alert signal 23 to the PVPU 12. At this point, the PVPU 12 may either terminate transmission of the voice packets 24 thereby ceasing transmission of voice packets to the network, or the PVPU 12 may buffer the voice packets 25 for later transmission. Regardless of either the termination or buffering of the voice packets, all transmission of voice packets to the network ceases upon receipt of an early tone detection.

Following generation of the alert signal 23 indicating possible presence of DTMF digits, the PVPU 12 must wait for qualification of DTMF digits 26. In the event that the DTMF digit is qualified 27, typically after 30-40ms, the DTMF detector in the TDU 11 sends a Detect On signal 28 to the PVPU 12 and any buffered packets are dropped 31, and the voice channel remains off. The PVPU 12 also sends the out of band DTMF detect message 30 for transmission via TCP to the receiving side

of the transmission and the PVPU 12 waits for termination of the DTMF 34. When the DTMF digit is no longer detected by the TDU 32, the TDU sends a Detect Off signal 33 to the PVPU 12 and transmission of voice to the packet network is resumed 35. The TDU 11 returns to the waiting mode for a tone state 21.

If the Detect On signal is not received for a certain timeout period 36 after receipt of the Alert signal 23, the voice transmission resumes 35, including transmission of all of the buffered packets 37. Accordingly, the absence of a Detect On signal following receipt of an Alert signal 23 is indicative that the DTMF detector was falsely triggered after only a 5ms delay in transmission of the signal.

Because many varying and different embodiments may be made within the scope of the inventive concept herein taught, and because many modifications may be made in the embodiments herein detailed in accordance with the descriptive requirements of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

CLAIMS

We Claim:

1. A method of detecting tones in a signal, comprising the following steps:

utilizing a tone detection unit for providing early detection of control tones in said signal;

providing a packet voice protocol unit for controlling transmission of said signal through said network; and

providing reliable transport of said control tones and said signal through said network.

2. The method of detecting tones in a signal of claim 1, further comprising generating an alert signal to the packet voice protocol unit following tone detection and prior to tone confirmation.

3. The method of detecting tones in a signal of claim 2, wherein said alert signal being generated following a 5 ms duration of tone detection.

4. The method of detecting tones in a signal of claim 2, further comprising ceasing transfer of voice packets to the network following receipt of said alert signal.

5. The method of detecting tones in a signal of claim 4, further comprising qualifying said control tones.

6. The method of detecting tones in a signal of claim 5, further comprising dropping buffered voice packets upon qualification of said control tone.

7. The method of detecting tones in a signal of claim 5, further comprising buffering said voice packets

for later transmission upon non-qualification of said control tone.

8. The method of detecting tones in a signal of claim 5, further comprising said tone detection unit sending a Detect On signal to said packet voice protocol unit and ceasing transmission of said voice signal upon qualification of said control tone.

9. The method of detecting tones in a signal of claim 8, further comprising said packet voice protocol unit sending out of band control tones detect signal to a receiving side of said transmission.

10. The method of detecting tones in a signal of claim 9, wherein said signal being sent via transmission control protocol.

11. The method of synthesizing a signal of claim 10 further comprising said packet voice protocol unit waiting for termination of said transmitting tone.

12. The method of synthesizing a signal of claim 11, said tone detection unit sending a detect off signal to said packet voice protocol unit upon lack of detection of tone by said tone detection unit.

13. The method of synthesizing a signal of claim 12, resuming transmission of said signal to said voice packet network.

14. The method of synthesizing a signal of claim 13, wherein said tone detection unit being in a tone detect mode.

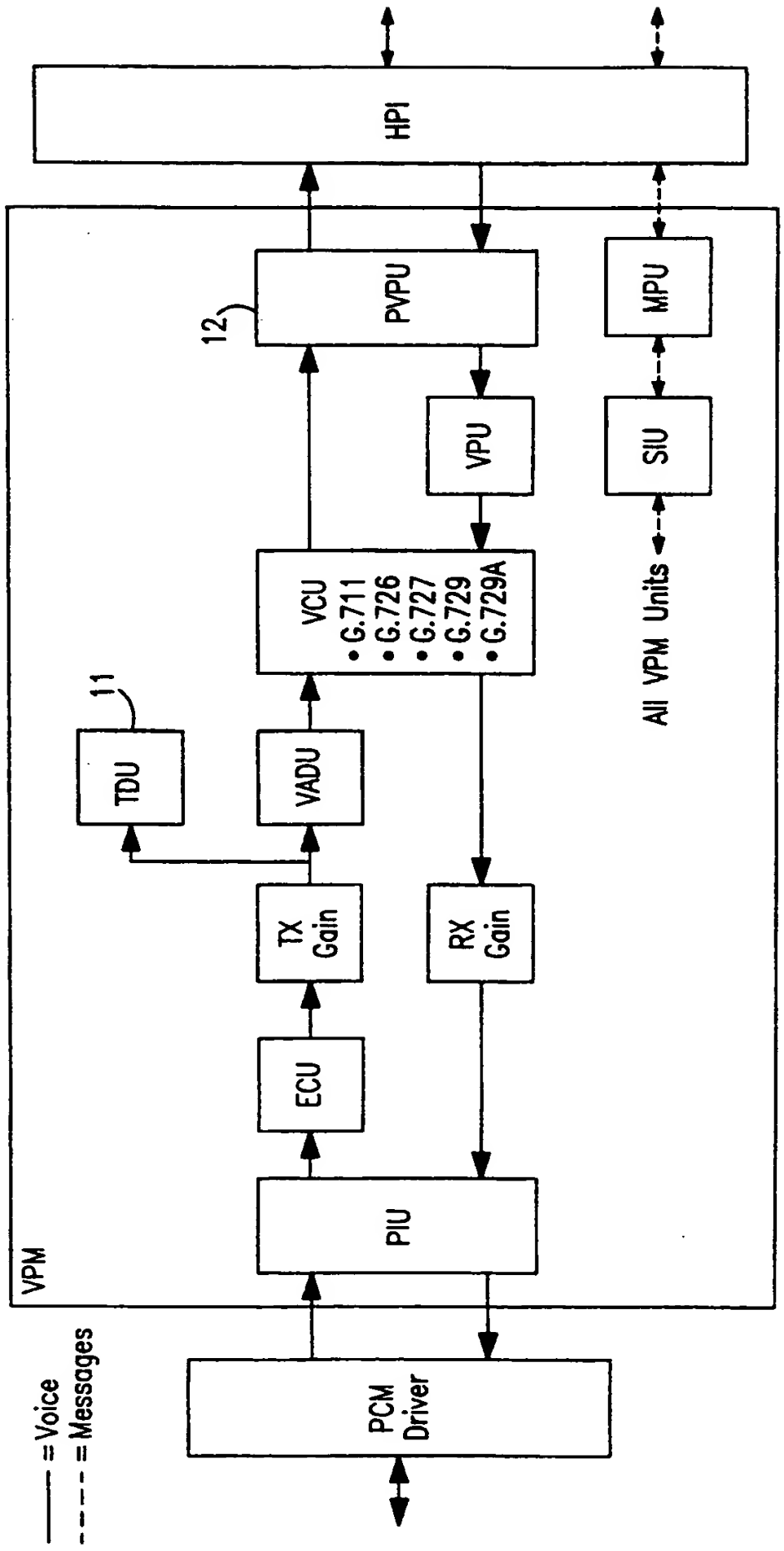


FIG. 1

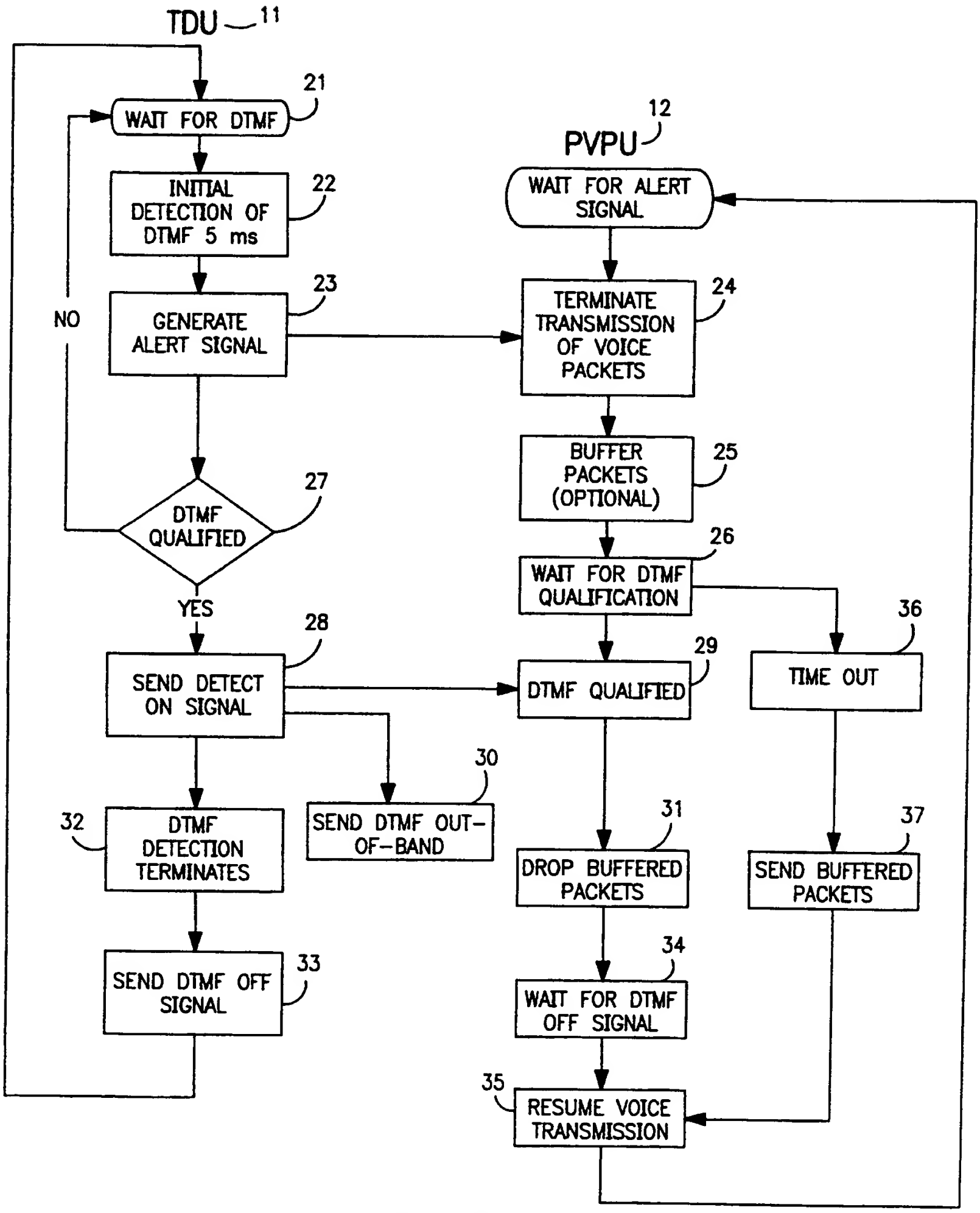


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/18401

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :Please See Extra Sheet.
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/242, 244, 389, 428, 429, 525, 526; 379/341, 418, 93.18, 93.26; 340/825.06, 825.16, 825.17

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST, DIALOG, EAST, IEEE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,868,872 A (ROBERTS et al) 19 September 1989, col 1, lines 54-68, col. 2, lines 1-2, 11-65	6,7 --- 1-5, 8-14
Y	US 5,721,729 A (KLINGMAN) 24 February 1998, col. 3, lines 1-13, col. 5, lines 24-67, col. 6, lines 1-35, col. 7, lines 25-67	1,2,8-10
Y	US 5,666,357 A (JANGI) 09 September 1997, col. 2, lines 18-67, col. 3, lines 1-4	3-5
Y	US 5,295,178 A (NICKEL et al) 15 March 1994, col. 5, lines 60-69, col. 6, lines 36-69, col. 18, lines 3-37	11-14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

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A. CLASSIFICATION OF SUBJECT MATTER:
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